AMENDED SPECIFICATION

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PATENT SPECIFICATION

1,073,741

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DRAWINGS ATTACHED

Inventor: PHILIP TREVOR SLACK

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Int. Cl.:— B 29 c // D 01 b, h, D07

COMPLETE SPECIFICATION

Process and Apparatus for producing Multifilament material and products produced therefrom

We, PLASTICISERS LIMITED, a British Company whose Registered Office is situate at Old Mills, Drighlington, near Bradford, West Riding, Yorkshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the production of an improved multifilament material, a process for its production and apparatus for carrying out the process.

According to the present invention a process is provided for the production of multifilament material which comprises splitting, cutting or slitting a continuously moving strip, tube or sheet of synthetic resinous material oriented in a longitudinal direction into a plurality of strands, adjacent strands being integrally joined together at regularly spaced intervals along the length thereof by bringing a plurality of rows of cutting edges or needles disposed in spaced parallel relationship over the surface of a rotating drum consecutively into cutting relationship with said moving strip, tube or sheet, the cutting edges or needles in adjacent rows being in staggered relationship.

The sheet, tube or strip is preferably under tension when it is slit, cut or split.

The strip or sheet of orientated synthetic resinous material may be of any desired thickness as long as it can be slit, cut or split into a plurality of strands as described above, convenient thicknesses have been found to be up to 15 thousandths of an inch preferably about 10 thousandths of an inch for many uses. For other uses the material may have a thickness of e.g. 380 microns or less, preferably not more than 250 microns.

The synthetic resinous material may be any such material which is capable of being formed into a continuous strip or sheet and which can be orientated. Examples of such materials are polyalkenes (e.g. polyethylene, polypropylene, etc.), polyamides (e.g. nylon), polyesters (e.g. polyterephthalic esters).

The strip, tube or sheet has rows of parallel generally longitudinal slits at spaced intervals along the length of the strip or sheet, the rows of slits being displaced laterally with respect to one another. The rows of slits may also overlap, if desired, the slits in one row being formed partly between the slits in an adjacent row.

The strip, tube or sheet is divided by forming a plurality of slits so disposed that on lateral expansion of the divided strip or sheet a net-like structure is formed.

The method of the invention produces a web or net-like planar or tubular structure consisting of strands of longitudinally orientated synthetic resinous material, said strands being integrally joined together to define the spaces in the web or net-like structure, the thickness

of the joints being equal to that of the individual strands which are joined.

The method of the invention produces a strip, tube or sheet of longitudinally orientated synthetic resinous material having formed therein a plurality of generally longitudinally disposed slits disposed in spaced parallel relationship, the slits being so disposed that expansion of the strip, tube or sheet in a lateral direction produces a net-like structure.

The invention also includes apparatus for carrying out the method which comprises supply means for delivering a continuously moving strip, tube or sheet of longitudinally orientated synthetic resinous material, tensioning means for tensioning a section of said continuously moving strip, tube or sheet and cutting means which engages in cutting relationship with said tensioned section of the strip, tube or sheet, the cutting means comprising a rotatable drum having disposed over the surface thereof a plurality of rows of cutting edges or needles in spaced, parallel relationship, the cutting edges or needles in adjacent rows being in staggered relationship. Such apparatus may of course also include orientating means for orientating the strip, tube or sheet and also extruding means for extruding the strip, tube or sheet of synthetic resinous material.

A variety of effects can be produced by the method of the invention including net-like structures.

Any one of the multifilament materials of the present invention may be twisted to form a continuous fibre or may be cut into staple fibre if desired. Such fibres whether continuous or staple may be used either alone or in admixture with other fibres, both natural and synthetic, to form cords, ropes, twine or in

According to a further embodiment therefor the method of the invention provides fibres comprising multifilament material as defined above, and also ropes, twine, cord, yarn or textile materials manufactured therefrom.

The multifilament material produced by the method of the present invention has a soft handle and a high degree of flexibility and fibres produced therefrom have a softer handle and higher degree of flexibility than monofilaments of the same diameter, whilst retaining a high tenacity. It is also possible to produce fibre which has a higher tenacity than the material before twisting to form the fibre. These properties are highly advantageous in the production of ropes, cords, twine and textile materials and constitute a marked improvement over the same materials produced from monofilament. Ropes, cords and twine produced from the multifilament material of the invention also have improved gripping properties over such products produced from monofilament.

It has further been found that by passing the multifilament material or fibre produced therefrom of the present invention between two surfaces under pressure and moving relative to one another a bulking effect is achieved and the material or fibre acquires a degree of elasticity, the extent of which depends on the pressure applied and the duration of the treatment.

According to a further embodiment of the invention therefore a process is provided which comprises passing a multifilament material produced by the process of the present invention or a fibre or yarn produced therefrom between two relatively moving surfaces for a period of time and under a sufficient pressure to produce a bulking effect on the material, fibre or yarn. A scribbing or lapping device may be used for this process. The orientated strip, tube or sheet material may be produced by any method. If desired the production of the orientated strip, tube or sheet may be carried out concurrently with the dividing of the strip in the manner of the present invention and a continuous process involving the production of sheet material and if desired further splitting to form strips, orientation of strip, tube or sheet and cutting or slitting according to the invention may be carried out as a continuous process. The further steps of twisting to produce fibre, or cutting to produce staple fibre and/or bulking and further treatment to form yarn may also be incorporated in such a continuous process. The denier of the resulting fibre will depend on the degree of stretching in the orientation and on the original width of the strip, tube or sheet. For a given degree of stretch, the denier may be varied over a wide range by varying the width of strip produced before orientation. It is thus possible to vary the denier continuously by relatively minor adjustments of the cutters which divide the sheet material before orientation thereof, and it is not necessary to shut down the plant in order to change from one denier to another. Continuous fibres having the same or varying denier along the length thereof can be produced.

A continuous process from resin mixture to multifilament material is illustrated in the accompanying drawing which is a diagrammatic illustration of such a continuous process for sheet material. It will be appreciated that if a tube is required, the slitter shown will be absent, and if strip material is required, a further slitter having a plurality of cutters would be positioned before the first godet set, and a plurality of orientating equipments would be provided, one for each strip produced. It will also be appreciated that the multifilament material leaving the rotating comb or slitter may be twisted before collection, or may be cut into staple fibres. The rotating combs shown in the drawing have the pins mounted in the preferred manner at an angle to the tangent to the surface to avoid tearing off of fine strips from the orientated

strip, tube or sheet. In place of the rotating comb, cutters may be used. Bulking of the multifilament material or fibre or yarn produced therefrom may also be effected if desired.

The present invention will now be further illustrated by reference to the drawings accompanying the Provisional Specification which show a continuous process from resin mixture to multifilament material.

Referring to the drawings accompanying the Provisional Specification raw materials for the production of tubes are fed into extruder 10 where they are heated and extruded through die 12. Air is simultaneously blown through die 12 thus blowing a tube 14 having a diameter greater than the diameter of the die 12. The tube 14 of synthetic resinous material is passed through air cooling ring 16 and then through a pair of nip rollers 18 from which the tube 14 leaves in a flattened state. The tube 14 still in the flattened state is then passed over a series of tension rolls 1, 2 and 3. A slitter 20 is provided between tension rolls 2 and 3, which slits the edges of the tube 14 thus providing two sheets of synthetic resinous material 22 and 24. These sheets of material can then be either collected on rolls A and B or, if the speed of production of these sheets will allow, they can be passed straight on to the next stage of production (see dotted lines). Each of the sheets of synthetic resinous material either direct from the slitter or from storage rolls is then passed through a series of rolls 26, a hot water bath 28 (or hot air chamber) which preferably has a length of at least four feet, and then through a second series of rolls 30. The rolls 30 rotate at a speed which is faster, preferably 5 to 10 times faster, than the speed of rolls 26. This speed differential together with the heating effect provided by the water bath, which is preferably at a temperature of 80 to 100°C., more preferably 98 to 100°C., results in the orientation of the sheet material. The orientated sheet material is then split, cut or slit by a rotating slitter 32 which is driven and the multifilament material so produced collected on a series of collecting rolls 34.

It will be appreciated that if a tube is required, the slitter 20 will be absent, and if strip material is required, a further slitter having a plurality of cutters would be positioned before the first set of rolls 26, and a plurality of orientating equipment would be provided, one for each strip produced.

It will also be appreciated that many other modifications in the apparatus shown in the drawings accompanying the Provisional Specification can be made. For example the water bath may be replaced by a steam jacket, or by a heated contact plate. A preferred form of contact plate has been found to be of hollow cross section having a curved lower portion under which the sheet material passes. The contact plate is preferably made from copper or brass and preferably contains oil which is heated to the desired temperature by a heating element or other means. For polyethylene the temperature at which orientation is found to occur readily is about 100°C. so that any of the above methods may be used. However when using polypropylene orientation does not occur readily until about 120°C and therefore it is better to use the contact plate method when using polypropylene. If the material is in the form of a tube it is better not to employ a heated contact plate since only one side of the two joined superimposed sheets will contact the plate.

When using the contact plate the sets of rolls 26 and 30 may each be replaced by a set of nip rollers of which the driven roller is made of steel and the other roller is free running and has a rubber surface. The nip is preferably adjustable.

It has been found that better results are obtained if the splitting, cutting, or slitting takes place while the sheet material is under tension and a further set of rolls similar to rolls 26 may therefore be inserted between slitters 32 and collecting rolls 34. These additional rolls are preferably run at a speed 3 to 5% greater than rolls 30 in order to produce the tensioning effect.

Example

A tubular synthetic resinous material of wall thickness equal to 0.002 inches was blown on a Rototruder R040—20D from a high density polythene resin having a melt index of 0.3. The temperatures in the extruder ranged from 300°F in the feed zone through 347°F in the centre zone and 392°F in the final zone to 460°F at the die head and the die had a diameter of 75 mm producing a lay flat width of 8 ins. The screw speed was 40 r.p.m. and the nip height above the floor 106 ins. Temperature at the nip was 81°C.

The tube so produced was slit to produce two sheets of synthetic resinous material which were collected on rolls. The material on each of these rolls was then passed through a first set of nip rolls (one steel, one rubber surfaced as described above) rotating at 30 r.p.m. under a contact plate heated to a temperature of about 100°C and through a second set of nip rolls similar to the first set and rotating at between 5 and 10 times the speed of the first sets. The sheet material was then slit by a slitter as shown in Fig. 1 the needles of which were in spaced parallel relationship and moving at a fairly rapid rate into and out of the path of the sheet material. The slit sheet material was then passed through a set of rolls rotating at a speed between 3 to 5% in excess of the speed of the second set of nip rolls and the web-like material so produced was collected on collection rolls.

WHAT WE CLAIM IS:—

1. A process for the production of multi-

filament material which comprises splitting, cutting or slitting a continuously moving strip, tube or sheet of synthetic resinous material orientated in a longitudinal direction into a plurality of strands, adjacent strands being integrally joined together at regularly spaced intervals along the length thereof by bringing a plurality of rows of cutting edges or needles disposed in spaced, parallel relationship over the surface of a rotating drum consecutively into cutting relationship with said moving strip, tube or sheet, the cutting edges or needles in adjacent rows being in staggered relationship.

2. A process as claimed in claim 1 in which said strip or sheet of orientated material has a thickness of 380 microns or less.

3. A process as claimed in claim 2 in which said strip of orientated material has a thickness of not more than 250 microns.

4. A process as claimed in any of the preceding claims in which said synthetic material is a polyalkene, a polyamide or a polyester.

5. A process as claimed in claim 4 in which said synthetic material is polyethylene, polypropylene, nylon or polyterephthalic ester.

6. A process as claimed in any of claims 1, 4 or 5 in which said strip or sheet of orientated material has a thickness of not greater than 15 thousandths of an inch.

7. A process as claimed in claim 6 in which said strip of orientated material has a thickness of ten thousandths of an inch.

8. A process as claimed in any of the preceding claims in which said sheet, tube or strip is under tension when it is split, cut or slit.

9. Fibres comprising multifilament material produced by the method claimed in any of claims 1 to 8.

10. Rope, twine, cord, yarn or textile material manufactured from fibres as claimed in claim 9.

11. A process which comprises passing a multifilament material produced by the method claimed in any of claims 1 to 8 or a fibre or yarn produced therefrom between two relatively moving surfaces for a period of time and under sufficient pressure to produce a bulking effect on the material, fibres or yarn.

12. A process as claimed in claim 11 in which a scribbling or lapping device is used.

13. A process as claimed in claim 1 substantially as hereinbefore described with reference to and as illusutrated in the drawings accompanying the Provisional Specification.

14. A process as claimed in claim 1 substantially as hereinbefore described in the Example.

15. Apparatus for carrying out the method claimed in claim 1 which comprises supply means for delivering a continuously moving strip, tube or sheet of orientated synthetic resinous material, tensioning means for tensioning a section of said continuously moving strip, tube or sheet and cutting means which engages in cutting relationship with said tensioned section of the strip, tube or sheet, the cutting means comprising a rotatable drum having disposed over the surface thereof a plurality of rows of cutting edges or needles in spaced parallel relationship, the cutting edges or needles in adjacent rows being in staggered relationship.

16. Apparatus as claimed in claim 15 which includes orientating means for orientating said synthetic resinous material.

17. Apparatus as claimed in claim 15 or 16 which includes extrusion means for extruding said strip, tube or sheet.

18. Apparatus as claimed in claim 15 substantially as hereinbefore described with reference to and as illustrated in the drawings accompanying the Provisional Specification.

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1073741 AMENDED SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

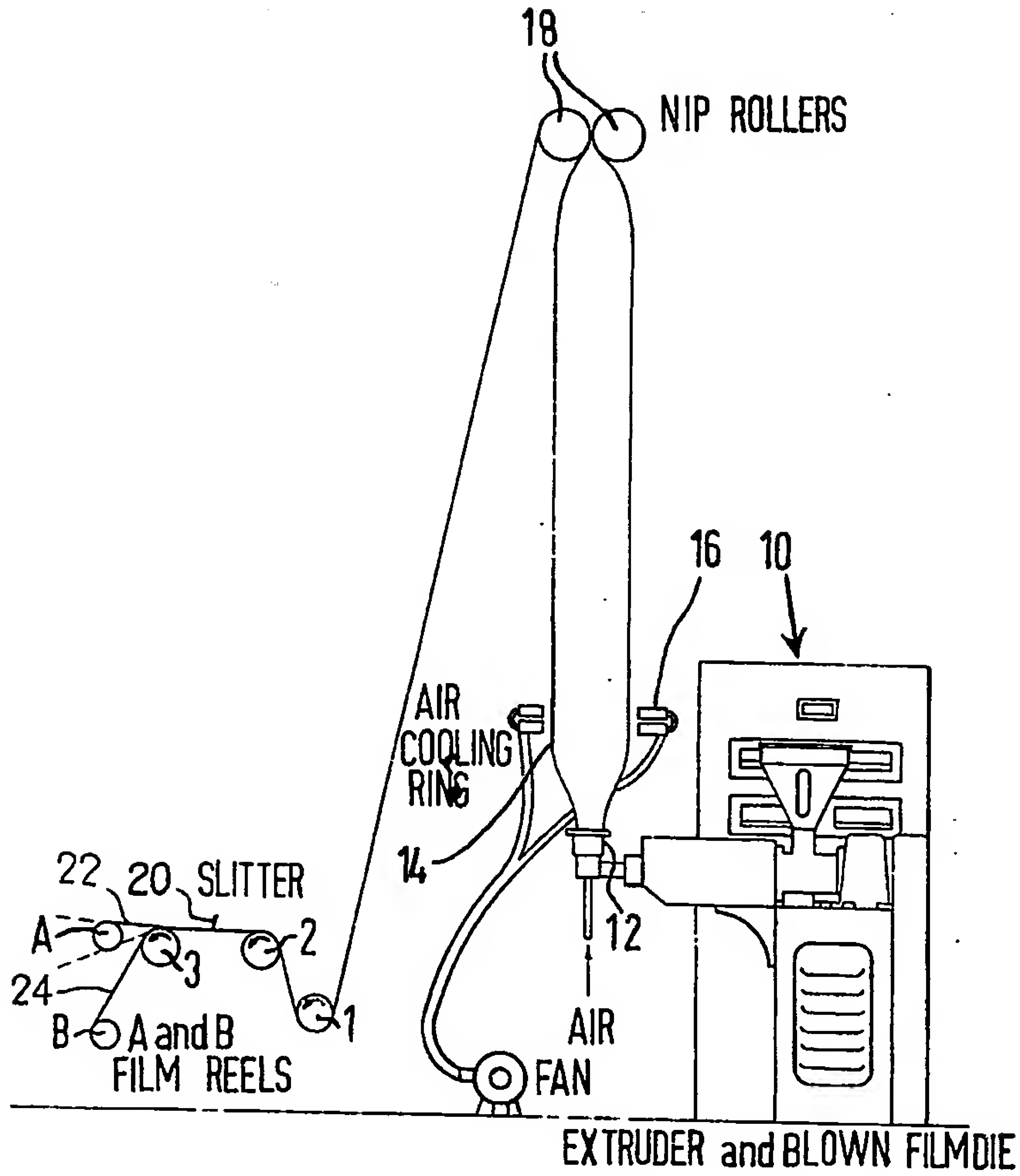

FIG.1A.

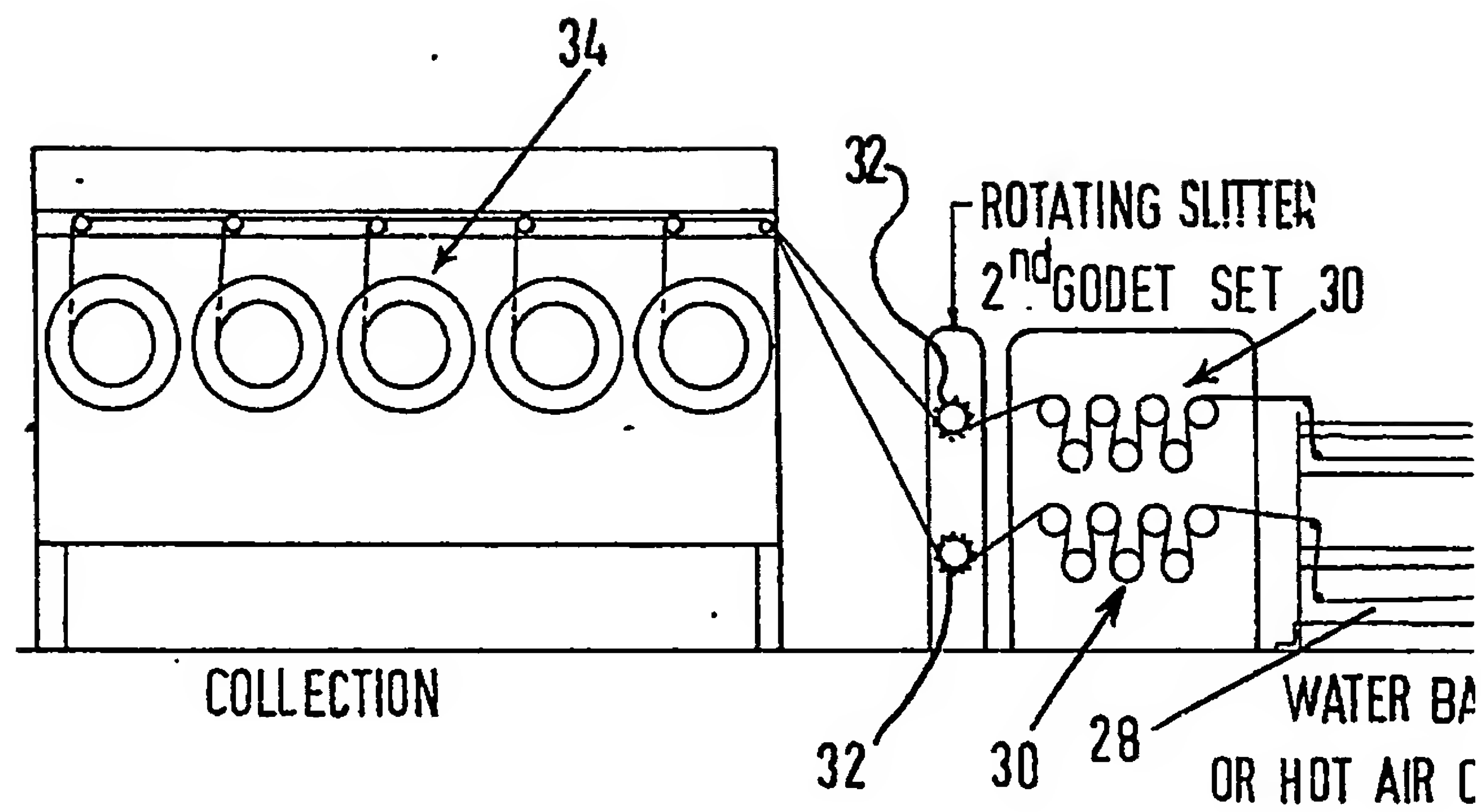
34
32
ROTATING SLITTER
2nd GODET SET 30
COLLECTION
32
30
28
WATER BA
OR HOT AIR C

FIG.1

1073741 AMENDED SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

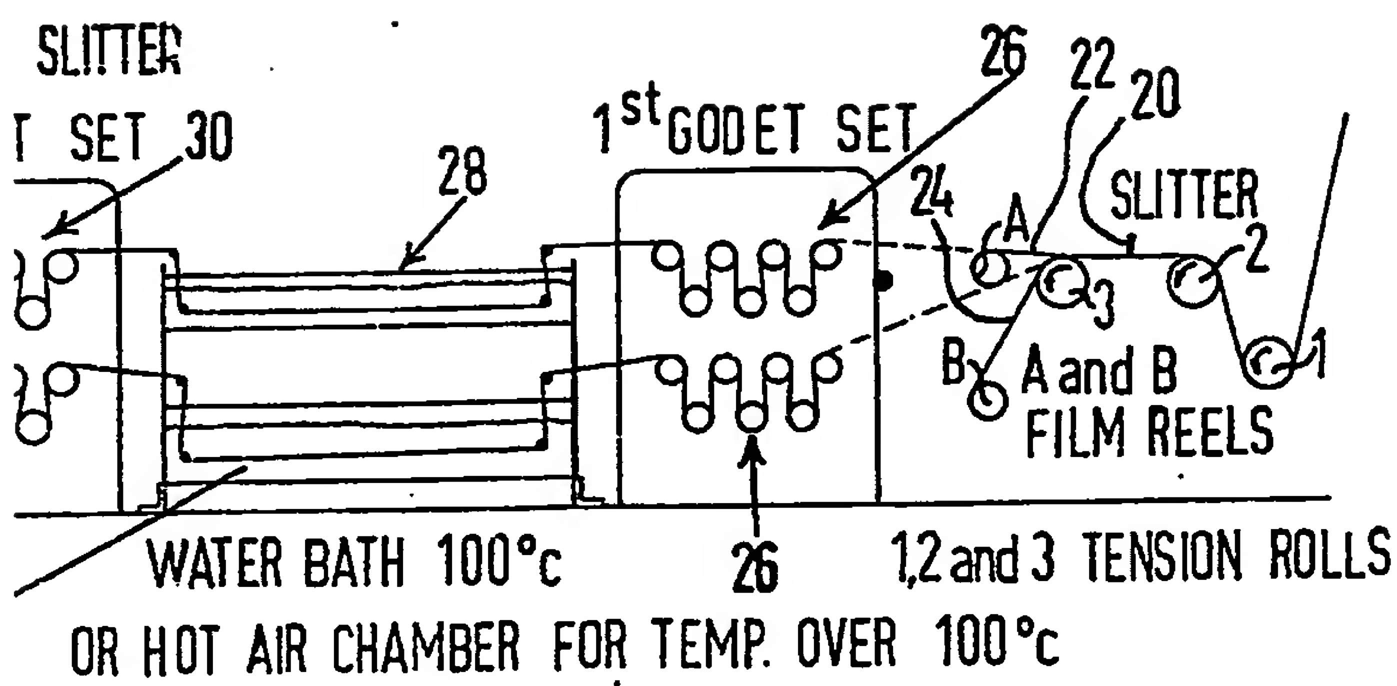

FIG. 1 B.

1073741 2 SHEETS

AMENDED SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale

Sheet 2

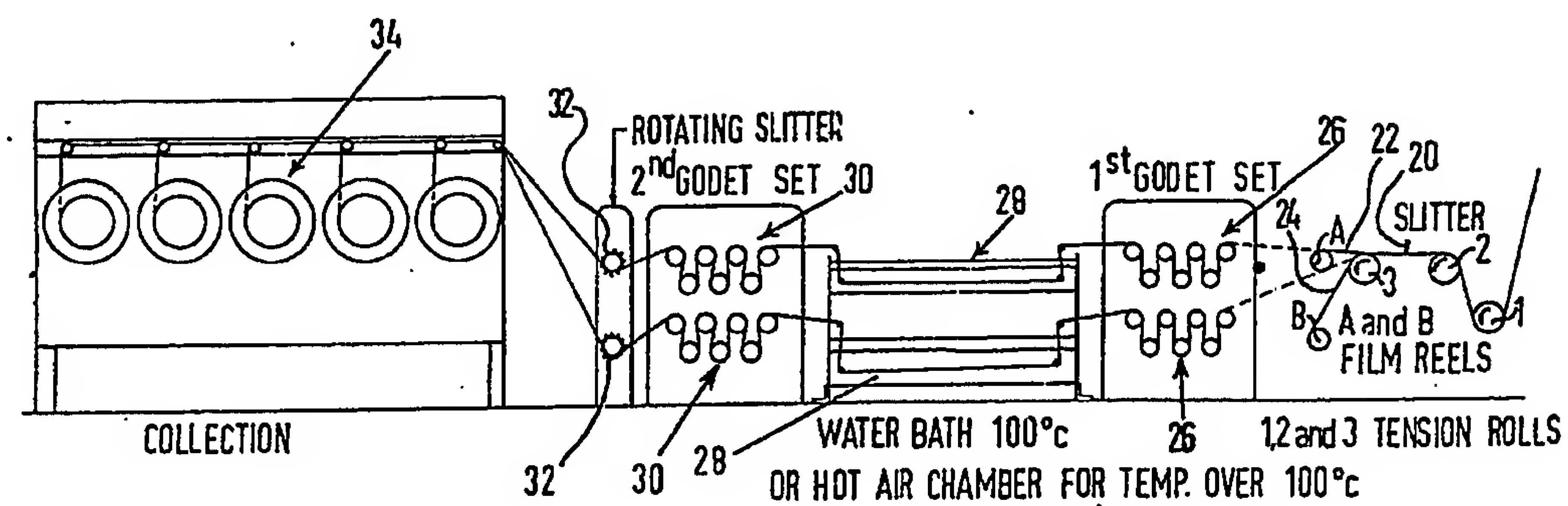

FIG.1B.